

APM 153 Assignment Two – Solving Systems of Linear Equations and Inverses

Instructions : Change the Current Directory in Matlab to your USB drive, create a new diary file **Assignment2.txt** and turn the **diary on**.

PART ONE: Solve the following series of equations using matrix math in Matlab. You are solving for the unknowns in the equation where the unknowns (x,y,z, etc.) = $A^{-1} * b$. Once you have calculated the unknowns using matrix math, use some other technique in Matlab to check your results.

$$\begin{aligned}(1) \quad & 2a + 3b - 4c - 2d = 12 \\ & -3a - 4b - 7c + d = 17 \\ & 12a - 3b + 4c - 2d = 2 \\ & 23a - b + c + 3d = 7\end{aligned}$$

$$\begin{aligned}(2) \quad & 3w + 7x + 2y - 9z = 0 \\ & \quad \quad x + y + z = 7 \\ & -2w \quad \quad - 3y + z = -5 \\ & 10w + x - 2y + z = 18\end{aligned} \quad \text{(hint: if a coefficient is not in one of the equations, what value do you put into the matrix?)}$$

$$\begin{aligned}(3) \quad & 17x + 13y + 21z = 3 \\ & 18x + 14y + 22z = 2 \\ & 19x + 15y - 24z = 1\end{aligned}$$

PART TWO Inverses

Test the following matrices to see if they have an inverse and if they do not, explain why the matrix does not have an inverse. Write your explanation into the diary file after you import it into MS Word. (Hint: How do you calculate the **determinant** of a matrix?)

$$(1) \quad A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

$$(2) \quad B = \begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & 6 \end{bmatrix}$$

$$(3) \quad C = \begin{bmatrix} 1 & 8 & 12 & 16 \\ 2 & 7 & 11 & 15 \\ 3 & 6 & 10 & 14 \\ 4 & 5 & 9 & 13 \end{bmatrix}$$

$$(4) \quad D = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

PART THREE Cramer's Rule

Cramer's Rule is another method for solving systems of linear equations using the **determinant**. Cramer's Rule states that the relationship between the coefficients for one unknown and the coefficients for the other unknowns can be given as the ratio of two determinants. We can use this ratio to solve for one unknown at a time.

(1) To use Cramer's Rule we first **replace** one of the columns in the matrix of coefficients with the column vector from the **results**.

(2) Given the system of coefficients from Part One, Number 3 above

$$\begin{array}{rcl} 17x + 13y + 21z & = & 3 \\ 18x + 14y + 22z & = & 2 \\ 19x + 15y + 24z & = & 1 \end{array} \quad \begin{array}{l} \text{the matrix of the coefficients and the column} \\ \text{vector of the results are shown below.} \end{array}$$

$$A = \begin{bmatrix} 17 & 13 & 21 \\ 18 & 14 & 22 \\ 19 & 15 & 24 \end{bmatrix} \quad b = \begin{bmatrix} 3 \\ 2 \\ 1 \end{bmatrix}$$

(3) The first column in the matrix A represents the coefficients of **x**. If we replace that first column with the values from the column vector b, we create what is known as an **augmented matrix**, "with respect to x", which we represent as **Aaug_x**.

$$\text{if } A = \begin{bmatrix} 17 & 13 & 21 \\ 18 & 14 & 22 \\ 19 & 15 & 24 \end{bmatrix} \quad \text{then} \quad A_{\text{aug}_x} = \begin{bmatrix} 3 & 13 & 21 \\ 2 & 14 & 22 \\ 1 & 15 & 24 \end{bmatrix}$$

(4) Finally, we can calculate the value of x as the ratio of the determinants of the two matrices.

$$x = \det(A_{\text{aug}_x}) / \det(A)$$

(5) We can make augmented matrices easily by editing the matrix A in Matlab.

(6) First set $A = \begin{bmatrix} 17 & 13 & 21 \\ 18 & 14 & 22 \\ 19 & 15 & 24 \end{bmatrix}$ in Matlab.

(7) Next, copy the matrix A to Aaug_x by typing **Aaug_x = A**

(8) Open up Aaug_x in the **Array Editor** by double clicking on the word Aaug_x in the Workspace Window.

(9) Replace the first column of numbers with the values from the column vector b. Close the Array Editor and the new values will be saved in Aaug_x. To check this, type Aaug_x in the Matlab command window and press Enter.

(10) Solve for x by typing $x = \det(\text{Aaug_x}) / \det(A)$

(11) Solve for y and z by creating augmented matrices Aaug_y and Aaug_z.

(12) We will go over this material again in lecture.

(13) Solve the following system of equations using Cramer's Rule.

$$\begin{aligned} 3x + 2y + z &= 7 \\ x + y + z &= 2 \\ y - z &= 0 \end{aligned}$$

(14) For Assignment2 you will turn in a hardcopy of your MS Word document containing the edited diary file with,...

Name, Date, etc.

Part One - Solve the three systems of equations using Matrix Math

Part Two - Determine if each of the four matrices has an inverse and explain why not if it does not.

Part Three - Solve the two systems of equations using Cramer's Rule

Getting Help With Your Homework

(1) In addition to grading your homework, each lab section has one or two TA's who can help you outside of class with questions about your homework.

(2) There are three TA's for the course and you are allowed to see any one of them during the week.

(3) All three TA's will have office hours and will be available for a two hour block of time in one of the computer labs each week. The current schedule is listed below.

LAB HOURS

Ms. Marilyn Markwei	9:30 - 11:30 Mondays 143 Baker Lab
Ms Shiuli Mahmud	9:30 – 11:30 Wednesdays 149 Baker
Mr. Sharad Singh	10:00 – 12:00 Thursdays 156 Baker Lab

(4) In addition, you can come and see your instructor (Dr. Joseph Cornell) in his office (B5 Marshall just about any time during the week except Thursdays when Dr. Cornell works off campus at the local science museum. Dr. Cornell is usually around at the times shown below.

Dr. Joseph Cornell's Office Hours.

Mondays	10:30 – 4:00
Tuesdays	10:30 – 5:00
Wednesdays	10:30 – 4:00
Thursdays	off campus
Fridays	10:30 – 4:00